FULL DUPLEX HEADSET WITH SEPARATE FUNCTION TRANSDUCERS FOR NOISY ENVIRONMENTS

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TECHNICAL FIELD

This invention relates to a device for simultaneously talking and listening in a full duplex mode of communication by utilizing a separate function transducer in each ear. Such devices are particularly useful in higher noise environments, such as noisy offices, inside moving automobiles and trucks, factories, heavy traffic, inside commuter trains, buses and loud music all of which having ambient noise levels from approximately 60 to greater than 90 decibels.

BACKGROUND

It is difficult to use a telephone handset in noisy environments, and particularly handsets for hand-held wireless phones. To reduce the impact of background noise, many people hold hand-held cell phones at one ear and use their index finger or the palm of their other hand to plug or cover the opposite ear. This scenario vividly portrays a necessary, yet uncomfortable method of talking and listening with portable telephones in noisy environments. With the rapid growth of portable telephones and the widespread use of these phones in noisy environments, there is a demand for new headset configurations that can significantly reduce the inconvenience of noisy interference.

SUMMARY

Addressing these and other concerns, the invention provides a headset with two ear pieces: one acting as a microphone, and the other acting as an earphone. Isolated from background noise and vibrations due to bone conduction, the

microphone ear piece converts voice sounds from the air column in the external ear canal into electrical signals. The earphone converts electrical signals from a telephony device into an audio output in the other ear piece. This headset configuration provides full duplex communication while isolating background noise.

A miniature piezoelectric, electret type, transducer is installed into one ear piece housing. This transducer is electrically dedicated to respond to a user's (outgoing) audio sounds. The audio sounds within the air column of the external auditory canal in one ear acoustically drive the miniature transducer producing electrical transmit (TX) signals without the outside noisy sounds. In order to reduce and isolate bone conduction voice sounds, which result in a concentration of low frequency voice energy, a sound conduction isolation "cup" serves as a jacket that surrounds the miniature transducer inside the housing.

A second miniature transducer is incorporated into a second identical ear-piece housing. This transducer receives the incoming RX electrical signal and produces acoustical sounds within the external auditory canal in the other ear of the user. The ear phone wires are joined together into one three conductor cord terminated to a standard 3.5 mm plug or 2.5 mm plug for direct plug-in. No additional electronic circuits or modifications are required. A cell phone, cordless telephone or regular corded telephone includes an external corresponding plug-in jack for receiving the headset plug.

The two transducers each perform a different function and eliminate the discomfort of covering the unused ear with a finger or hand when used in higher noise environments.

This invention provides a product, which is cost effective, reliable, convenient and more useful in providing hands-free, full duplex, clear communications.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of a full duplex headset, showing the electrical connection of earphone and microphone ear pieces to a standard plug.

Fig. 2 is a schematic diagram illustrating circuitry of the microphone ear piece shown in Fig. 1 in more detail.

Fig. 3 illustrates an example of a headset configuration in which the earphone and microphone ear pieces shown in Fig. 1 may be incorporated.

Fig. 4 illustrates how an ear piece of the headset shown in Fig. 3 rests within an ear of a user.

Fig. 5 is an exploded view of a microphone ear piece for the headset shown in Figs. 3 and 4.

Fig. 6 is an alternative example of a headset in which the earphone and microphone ear pieces shown in Fig. 1 may be incorporated.

Fig. 7 shows a cross-sectional view of an ear piece of the headset shown in Fig. 6.

Fig. 8 shows an alternative implementation of the microphone ear piece circuitry shown in Fig. 2.

DETAILED DESCRIPTION

Fig. 1 illustrates a schematic diagram of a full duplex headset. The headset has two ear pieces: an earphone ear piece (100) and a microphone ear piece (102). Each ear piece has two electrical terminals, with one serving as the common or "ground" node. A pair of wires (104, 106 and 108, 110) are connected to these terminals, and are ultimately joined in a single cord terminating in a connector plug (114). The wires connected to the ground node (104, 108) are joined together and terminate at the sleeve (112) of plug (114). The wire connected to the opposite terminal of the earphone relative to the common terminal is connected to the ring portion (116) of the

plug (114). On the other side of the headset, the wire (110) in the microphone (102) is connected to the tip portion (118) of the plug (114).

The earphone (100) contains a transducer (120) that converts an electrical signal into an audio output. The microphone ear piece (102) contains a transducer that converts an audio input into an electrical signal, which is communicated to a telephony device via the wires (108, 110).

By placing the microphone in the operator's ear, the transducer in the microphone can detect voice signals that pass from the users vocal cords through the operators head and out the external ear canal. Since the microphone is located inside the ear canal, ambient noise is filtered from the transducer.

Fig. 2 is a schematic diagram illustrating circuitry within the microphone ear piece in more detail. The circuitry within the ear piece in this particular implementation includes a piezoelectric transducer (200) coupled across the gate node (202) and drain node (204) of a field effect transistor (206). The drain node (208) of the field effect transistor (206) is connected to the wire (110) that extends from the ear piece (102). The source node of the field effect transistor is connected to the wire for common ground node (108).

When the wearer of the headset speaks, the resulting voice sounds in the air column within the external auditory canal drive the piezoelectric transducer (200). The field effect transistor (206) transfers the electrical signal induced by the voice sounds through the wire (110) and into interface circuitry within the telephony device. This interface circuitry is conventional, and may include a resistor (210) coupled between the input port (212) that receives signals from the wire (110), on one side, and the VCC power supply on the other side. The telephony device may also have an amplifier (214) and other conventional interface circuitry to process the incoming electrical signal. The common ground wire (108) is connected to one terminal of the

piezoelectric transducer (200). The drain of the field effect transistor (206) is coupled to ground via another port (216) of the telephony device.

The headset configuration shown in Fig. 1 can be incorporated into a variety of headsets. Fig. 3 illustrates one possible example of a headset configuration in which the circuitry shown in Figs. 1 and 2 may be incorporated. The headset shown in Fig. 3 is similar to the headsets typically used with portable radios, tape players, and CD players. Each of the ear pieces (304, 306) have a similar structure. In particular, each ear piece includes a circular disk portion (300, 302) with a flat face. When resting inside the ear, the face of the ear piece is designed to be oriented in the direction of the external ear canal. A grill (308, 310) on the face of the ear piece allows voice sounds to be communicated to the microphone and from the earphone transducers.

A neck portion (312, 314) of the ear piece housing extends from the disk portion (300, 302) and is connected to the headset frame piece (316, 318). A metallic headband (320) fits within a sleeve of the frame pieces (316, 318) and allows the user to adjust the size of the headset.

Fig. 4 shows an expanded view of the ear piece (306) from the headset shown in Fig. 3, resting within a user's ear (400). This particular illustration shows how the left ear piece (306) rests within a pocket of the ear such that the face (302) of the ear piece is oriented in the direction of the external ear canal (402). The neck portion (318) of the ear piece extends out of the ear and acts as a conduit for the cord carrying the two wires from the transducer inside the ear piece.

Fig. 5 is an exploded view of a microphone ear piece designed for the headset shown in Figs. 3 and 4. As shown in Fig. 5, the ear piece housing includes two principle parts: 1) a plastic, disk-shaped housing (500) formed into a unitary piece along with the neck portion of the housing (502); and 2) a cover (504) that encloses

the circular face of the housing (500). The cover (504) fits into an opening (501) in the housing (500) and has a grill portion (506) that allows audio sounds from the external auditory canal to pass into the housing (500) and drive a miniature microphone (508).

The microphone (508) is implemented with a piezoelectric transducer, and in particular, an electret-type transducer. The microphone sits within a cup (510) that acts as an acoustical isolator. The cup (510) fits tightly around the sides and rear of the electret and fills in the space between the electret and the inner walls of the ear piece housing (500).

The cup (510) acts as an acoustical isolator to prevent sounds attributable to bone conduction from reaching the microphone (508). Preferably, the acoustical isolator is made of a material that has a high air content isolate vibrations attributable to bone conduction. A variety of materials may serve this function, including, but not limited to, Styrofoam, plastic, wood, perlite, etc.

Fig. 6 illustrates another example of a headset configuration that can incorporate the circuitry shown in Fig. 1. This particular configuration is especially effective in high noise environments because each of the ear pieces (600, 602) have a nipple (604, 606) that penetrates into and fits snuggly within the wearer's external ear canal (402) (Fig. 4). The nipple (604, 606) comprises an umbrella-like shroud (608, 610) made of a soft, flexible material that conforms to the shape of the external auditory canal. The pinnacle of the shroud (608, 610) has an opening (612, 614) that allows air to pass into the housing and to the transducer within the housing. The stalk (616, 618) of nipples (604, 606) is made of a harder plastic and is roughly cone-shaped, with a decreasing circumference toward the openings (612, 614) of the nipples.

Fig. 7 shows a cross-sectional view of the nipple ear piece shown in Fig. 6. The stalk (618) of the nipple snaps onto an ear piece housing (700) that houses a piezoelectric microphone (702).

To reduce ear fatigue, the wires stemming from each ear piece extend through the housing and into the frame body (620, 622) of the headset (Fig. 6). This upward orientation of the wiring through the frame of the headset reduces the stress that would otherwise be directed to the ear piece if it extended from the bottom of the ear piece. While this particular configuration may tend to reduce fatigue on the ear, it is also possible to configure the ear pieces so that the wiring extends from the side or bottom of the ear piece housing.

It is important to note that the headset configurations shown in Figs. 4-7 represent only some examples of the many possible configurations in which the full duplex circuit configuration shown in Fig. 1 may be incorporated. While these configurations include a headset frame that fits over the wearer's head, it is also possible to implement the full duplex headset in a pair of ear pieces that are held to the user's head in some other fashion. One possible alternative is to have ear clips mounted on each of the ear piece housings that clip around the wearer's ears. Another possible alternative is to use ear pieces such as the ones shown in Fig. 6 that fit snuggly within the auditory canal without the need for external support from a headset frame.

The headsets described above provide hands-free full duplex communications without having to use an annoying microphone extension arm. A microphone does not have to be positioned near the mouth since the voice sounds are essentially provided through the ear canal.

Multiple transducer housing styles can be used to suit the various preferred choices of use. An ear piece attachment that protrudes outside the ear canal can be

used for less noisy environments. The lightweight ear microphones use small miniature electro-dynamics transducers weighing approximately 5 grams or .18 oz. to minimize fatigue. The lightweight piezoelectric transducers further improve performance and reduce weight. Lightweight head bands, ear supports, and contoured transducer housings, such as those designed for security personnel, and the hearing impaired, provide snug fit in the outer ear canal.

Fig. 8 shows a variation on the microphone ear piece circuit shown in Fig. 2. A filter circuit (698) includes a capacitor (710) and an inductor (712). The filter circuit (698) is coupled between the source and drain terminals of FET transistor (206). The capacitor (710) provides DC blocking between node (208) and node (216). The inductor (712) provides a low impedance at low audio frequencies and a high impedance at high audio frequencies. In one example, the inductor (712) is selected so that there is approximately ten times the impedance across FET (206) at 3000 Hertz than at 300 Hertz.

The filter circuit (698) attenuates the low frequencies associated with bone conduction and low audio frequencies. Thus, the circuit (698) filters out some of the unwanted bone conduction and low frequency voice components that may be picked up by the transducer (200). Since consonants are generally pronounced using higher frequency components, the circuit (698) also provides better sound detection for consonants. In one embodiment, the inductor is made from a circular core material and wire is wrapped around this circular core material.

A transmit circuit (713) is used in cellular phones, cordless telephones or phone handsets. The transmit circuit (713) includes a resistor (210) and a capacitor (714). A connection (718) is coupled to the tip (118) of the plug (114) (FIG. 1). The voltage of the transmit signal at connection (718) is increased before being amplified by amplifier (214).

A person skilled in the art will be able to practice the present invention in view of the present description, where numerous details have been set forth in order to provide a more thorough understanding of the invention. In other instances, well-known features have not been described in detail in order not to obscure unnecessarily the invention.

While the invention has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense. Indeed, it should be readily apparent to those skilled in the art in view of the present description that the invention can be modified in numerous ways. Applicant regards the subject matter of the invention to include all combinations and subcombinations of the various elements, features, functions and/or properties disclosed herein.

The following claims define certain combinations and subcombinations, which are regarded as novel and non-obvious. Additional claims for other combinations and subcombinations of features, functions, elements and/or properties may be presented in this or a related application for patent.